

2 Metadata and NWS history

2.1 General Description

In Montana, there have been well over 1300 weather stations that have operated for some period of time since the mid-1860s. In general, the stations operated periodically for both short and long periods of time. Some stations changed locations by a few feet to several miles. There are many weather monitoring networks in the state.

Routine surface weather observations are nominally taken every hour at **17** first order stations in Baker, Billings, Bozeman, Butte, Cut Bank, Dillon, Glasgow, Great Falls, Havre, Helena, Jordan, Kalispell, Lewistown, Livingston, Malmstrom AFB, Miles City, Missoula, and Wolf Point. These are ASOS (Automated Surface Observing System) stations and began operations in 1996. With its introduction came a major change in reporting weather observations. The METAR code was implemented and measurements were recorded in metric instead of English units. Slight rounding differences in temperature and dew point, as well as measuring cloud cover in octants instead of tenths were just some of the resulting differences. There are **28** other stations using the Automated Weather Observing System (AWOS).

Additionally, in 2015, there were **72** Montana Department of Transportation (MDT) sites across the state that also provide 15-minute, or more often, observations, although cloud data are not recorded. A few do record visibility and rainfall. There were **108** Remote Automated Weather Stations (RAWS) that are used to monitor fire potential in the various sectors of the state. These sites record temperature, wind, precipitation and some record soil conditions and radiation. **256** Cooperative Observer (COOP) stations mostly report daily maximums and minimums for temperature, and daily totals for precipitation and snow. An additional **69** locations operate Fischer-Porter rain gauges that nominally record precipitation at 15-minute intervals. About **278** stations operated under the Hydrometeorological Automated Data System to support flood and flash flood warnings, reporting at one to three hour intervals. There were **94** Snowpack Telemetry (SNOTEL) stations that measured the snow-water equivalent (SWE) at high altitude locations. SCAN (Soil Climate Analysis Network) (**6**) and Climate Reference Network (CRN) - (**5**) sites report air and soil temperatures, while Agricultural Weather Network (AgriMet) (**25**) report air and evaporation data. The North Dakota Automated Weather Data Network (NDAWN) operates **two** stations in Montana, both near Sidney. The Northern Plains Agricultural Research Station at Sidney operates **six** stations. These report air and soil temperature data. Hourly air monitoring sites are operated at **19** locations in Montana by the Department of Environmental Quality. **Four** weather radars operate in the state, at Missoula, Great Falls, Glasgow, and Billings. The state's **two** radiosonde stations at Glasgow and Great Falls provide two daily upper air soundings, reaching heights in excess of 100,000 feet. The University of Oregon's Solar Radiation Monitoring Laboratory operates a station at Dillon. The Surface Radiation Budget Network operated by NOAA Air Resources Laboratory has one station near Poplar. The Environmental Protection Agency operates an Ultraviolet Monitoring Program with one location in Glacier National Park. The US Department of Agriculture runs an ultraviolet-B station

near Poplar. This is to provide information on how ultraviolet light affects plants. The Ameriflux network measures carbon dioxide, water and energy fluxes. One station operates in Montana, near Poplar. GPS-Met data is available at three locations, Polson, Havre and Billings. This data gives integrated precipitable water information at these locations. Further, The Citizens Weather Observing Program (CWOP) includes more than 75 stations (76) across the state, DavisNet includes more than 135 stations, and the Weather Underground network includes more than 250 stations. Five stations are overseen by the Missoula Weather Forecast Office, while the Glasgow office operates 16. Further, the Community Collaborative Rain and Hail Study (CoCoRAHS) has more than 135 active participants measuring rain and snowfall throughout the year. All told, this is an impressive total of more than 1550 weather stations that report data anywhere from hourly to daily. Additionally, there are over 220 active webcams operating in the state.

| Network | Number | Reporting | Internet |
|--------------------|---------------|------------------|-----------------|
| ASOS | 17 | Hourly or more | Mesowest |
| AWOS | 28 | Hourly or more | Mesowest |
| MDT | 72 | Hourly or more | Mesowest |
| RAWS | 108 | Hourly | Mesowest |
| SNOTEL | 94 | Hourly or less | Mesowest |
| COOP | 256 | Daily | Mesowest |
| Fischer Porter | 69 | Hourly or more | NCDC |
| HADS | 278 | Hourly or more | Mesowest |
| SCAN | 6 | Hourly | Mesowest |
| CRN | 5 | Hourly | Mesowest |
| Agrimet | 25 | Hourly | Mesowest |
| NDAWN | 2 | Hourly | |
| MT DEQ Air | 19 | Hourly | |
| SRML | 1 | Hourly | |
| SRBN | 1 | Hourly | |
| UVA-A | 1 | Hourly | |
| UVA-B | 1 | Hourly | |
| Ameriflux | 1 | Hourly | |
| GPS-MET | 3 | Hourly | |
| CWOP | 76 | Hourly or more | Mesowest |
| DavisNet | 138 | Minute | DavisNet |
| Wx Underground | 251 | Minute | WUnderground |
| MSO WFO | 5 | Hourly or more | Mesowest |
| GGW WFO | 16 | Hourly or more | Mesowest |
| CoCoRAHs | 135 | Daily | CoCoRAHs |
| MCSCN | 20 | Hourly or more | Mesowest |
| Avalanche | 19 | Hourly | Mesowest |
| NP Ag Research Lab | 6 | Hourly | NPARL |
| BNSF | 8 | Hourly | |
| Webcams | 224 | | |

2.2 Chronology of the National Weather Service and observations in Montana

- 1805** - Lewis and Clark Expedition take weather observations along their journey through present-day Montana.
- 1807-1820** - Occasional weather observations from Fort Manuel (Ramon) near the mouth of the Bighorn River in Treasure county.
- 1809-1812** - Sporadic weather observations logged in journals of David Thompson at Saleesh House, near Thompson Falls.
- 1814** - The Surgeon General ordered surgeons to keep weather diaries.
- 1829-1866** - Occasional weather observations from Fort Union, near Frazer.
- 1845** - Telegraph became operational. Visionaries saw the possibility of “forecasting” storms by telegraphing ahead what they observed.
- 1848** - First volunteer weather observers recruited through the Smithsonian Institution.
- 1850-1871** - Occasional weather observations from Fort Owen, near Stevensville.
- 1862** - Weather observations started at Fort Benton.
- 1867** - Weather observations started at Fort Shaw.
- 1868** - Army begins weather observations near Bozeman, near the present-day campus of Montana State University.
- 1869** - Weather observations started at Deer Lodge.
- Prior to 1870** - Most observations taken at various forts required by government statute.
- 1870** - Weather observations started at Fort Logan and continued through 1908.
- 1870** - A joint resolution was passed authorizing “the Secretary of War to take observations at military stations and to warn of storms on the Great Lakes and on the Atlantic and Gulf coasts.”
- Within the Department of War, the Signal Service Corps existed. Since the new weather service was dependent upon a reliable communications system, the new weather service was placed under the Secretary of War because “military discipline would probably secure the greatest promptness, regularity and accuracy in the required observations.” It was assigned to the Signal Service Corps (organized in 1860) under the first name: The Division of Telegrams and Reports for the Benefit of Commerce.” The first storm warning was issued November 8, 1870, as a high wind warning for the Great Lakes.
- 1871** - Volunteer weather observations started at Virginia City.
- 1872** - Prior to June 10, 1872, the forecasts were only for the eastern United States, but on this date, Congress extended the service throughout the United States “for the benefit of commerce and agriculture.” There was still a significant lack of observational data west of the Mississippi River.
- Early forecasts were made for eight large districts (which covered the entire U.S.), three times daily. By October 1870, predictions were made for 24 hours for nine districts, and by 1886, forecasts were made for individual states. In 1888, forecast durations were extended to 36 hours and in 1898 extended to 48 hours.
- 1879** - Army begins regular weather observations at Ft. Keogh, near Miles City.
- 1883** - First tornado reported in Montana south of Butte in Silver Bow County. Six people injured.
- 1889** - Internal strife caused many problems in the Signal Service. By 1889, the problems

- had become so severe that President Benjamin Harrison recommended the transfer of the national weather service to the Department of Agriculture. On October 1, 1890, an act was signed into law effecting this transfer and the United States Weather Bureau was formed.
- 1891** – Weather Bureau becomes responsible for issuing flood warnings to the public.
- 1897** – First “Inland storm warnings” issued in Montana, for cold, windy and snowy conditions.
- 1910** – Weather Bureau begins issuing generalized weekly forecasts for agricultural planning.
- 1912** – First fire weather forecast issued in the U.S.
- 1916** – Fire Weather Service established, with all district forecast offices authorized to issue fire weather forecasts. The first fire district forecast office was at Medford, Oregon.
- 1923** – First deaths due to tornadoes in Montana. A tree fell on two men at a copper mine near Rivulet in Mineral county.
- 1937** – Weather Bureau begins radiosonde observations. Weather Bureau opens Great Falls office.
- 1940** – Weather Bureau transferred to Department of Commerce – the first official daily forecasts are issued.
- 1941-53** – Billings started and continued at the state forecast office.
- 1943** – Upper air observations began at Glasgow in June. Weather Bureau office opened.
- 1948** – Upper air observations began at Great Falls in January.
- 1940s** – Other weather offices opened in Missoula, Kalispell, Havre, and Glasgow.
- 1948** – March 25 – The first tornado warning issued in the U.S., for Tinker AFB in Oklahoma.
- 1953-1996** – State forecast office moved to Great Falls, and continued there through 1996. Nine large forecast zones covered the state.
- 1960** – First weather satellite, TIROS I, launched.
- 1965** – Environmental Science Services Administration (ESSA) created in Department of Commerce. Weather Bureau is an agency within ESSA.
- Early 1960s** – Weather radar (WSR-57) installed on Point Six near Missoula as a network radar and continued to operate through the mid 1990s.
- 1970** – National Oceanic and Atmospheric Administration (NOAA) created with the weather bureau as an agency under NOAA.
- 1970** – Soil Conservation Service begins deployment of SNOTEL stations across Montana, to assist in snowfall monitoring at headwater regions in the mountains.
- 1971** – Weather Bureau renamed as the National Weather Service.
- Mid 1970s** – Weather radars (WSR-74C) installed at Billings and Williston as a local warning radar and continued to operate through the mid 1990s. FPS-77 installed at Malmstrom AFB with the weather office in Great Falls tapping off this radar.
- mid 1970s** – Weather radio deployed in Montana with transmitters at Glasgow, Billings, Miles City, Great Falls, Havre, Helena, Missoula, Butte, and Kalispell.
- 1975** – First geostationary satellite launched into orbit.
- 1978-late 1990s** – Automation of Field Operations (AFOS) deployed and serviced field offices.

- 1985** – Nested Grid Model (NGM) becomes operational.
- 1993** – Automatic Surface Observing System (ASOS) deployment at airports started in Montana.
- 1994** – Montana DOT begins deployment of RWIS (Remote Weather Information Systems) across Montana. Eventually places 70 sensors, some with cameras.
- 1994** – Modernization of the NWS first brings WSR-88D (Doppler) radar to Montana. Radars installed at Glasgow, Billings, Great Falls, and Point Six near Missoula.
- 1995** – Modernization continues with the down-sizing of the forecast areas in Montana. In addition to Great Falls, new forecast offices open in Missoula, Glasgow, and Billings. Forty-two forecast zones (nearly one per county) covered the state. Weather offices closed at Kalispell, Helena and Havre.
- 1997** – Weather radio changes from a human voice to a computerized voice.
- 1998** – Another change in the forecast zone configuration increased the number of zones to 62. AWIPS deployed in Montana.
- 2002** – Weather radio expansion continues with new transmitters at Conrad, Browning, Lewistown, Bozeman, Baker, Circle, Glendive, Malta, Plentywood, Poplar, Scobey, and Jordan.
Montana Soil Moisture Environment Initiative begins in the state with local government purchase and deployment of weather stations to monitor air temperature, wind, and soil moisture and temperature conditions. Private weather stations also start to be added to internet sources
- 2003** – Gridded forecasts are released.
Weather radio installed at Dillon, Broadus and Livingston.
- 2004** – Another change in the forecast zone configuration increased the number of zones to 68. This affected south central Montana.
- 2005** – Additional weather radios installed at Hardin, Ryegate and Winnett, bringing the total to 28 in Montana.
- 2007** – Two more weather radio transmitters are added, for a total of 30 stations across the state.
- 2012** – Dual polarization of radar upgrades made in Montana.
- 2014/15** – AWIPS-2, a new generation of AWIPS is installed across the state.